GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL [ ] REVISION NO. _____

Project No. E-23-601 GTRI/~~GIT~~ DATE 5/5/83

Project Director: Art Koblasz School/~~Lab~~ ESM

Sponsor: VA Medical Center

Type Agreement: P. O. 508/D 30216 dated 4/20/83

Award Period: From 4/1/83 To 5/31/83 (Performance) 6/15/83 (Reports)

Sponsor Amount: Total Estimated: $ 4,680 Funded: $ 4,680

Cost Sharing Amount: $ _____ Cost Sharing No: _____

Title: Service Contract to Provide Administrative Assistance to VA Hospital

ADMINISTRATIVE DATA

OCA Contact Faith G. Costello

1) Sponsor Technical Contact:

VA Medical Center
1670 Clairmont Road
Decatur, GA 30033

Attn: Ms. Virginia Watkins
321-6111 X-351

2) Sponsor Admin/Contractual Matters:

Defense Priority Rating: None

Military Security Classification: None
(or) Company/Industrial Proprietary: _____

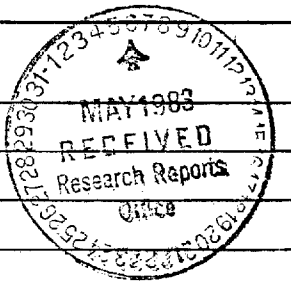
RESTRICTIONS

See Attached _____ Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with Sponsor, but none proposed.

COMMENTS:



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Send two copies of binding slip with volume.
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E-10314

FFICE OF CONTRACT ADMINISTRATION

I/CLOSEOUT SHEET

Date November 8, 1983

Project No. E-23-601 School/~~Unit~~ ESM

Includes Subproject No.(s) _____

Project Director(s) Art Koblasz GTRI / ~~GTRI~~

Sponsor VA Medical Center

Title Service Contract to Provide Administrative Assistance to VA Hospital

Effective Completion Date: 5/31/83 (Performance) 6/15/83 (Reports)

Grant/Contract Closeout Actions Remaining:

- ☐ None
- ☒ Final Invoice ~~& Report~~
- ☐ Closing Documents
- ☐ Final Report of Inventions
- ☐ Govt. Property Inventory & Related Certificate
- ☐ Classified Material Certificate
- ☐ Other _____

Continues Project No. _____ Continued by Project No _____

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Form OCA 60-1020

PROGRESS REPORT FOR E-23-601

May 15, 1983

1. Statement of the Problem

Rehabilitating a lower limb amputee requires extensive strength and coordination training, which can be accomplished using a bicycle ergometer. This is especially true when the patient is being fitted with a prosthesis. Most physical therapists encourage a dynamic exercise program which gradually improves the strength and endurance of the patient. However, commercially available ergometers are very expensive (e.g., $22,000 for computerized version of Cybex Dynamometer) and they are not able to accurately quantify the dynamic strength of the patient. Also most ergometer protocols are both boring and painful; therefore, it is usually difficult to arouse a maximum effort for long periods.

2. Hypotheses and Key Questions

The use of white-noise to characterize a nonlinear system has been successfully applied to various biological systems. The white-noise stimulus contains all possible combinations of stimuli and it is unpredictable (i.e., random). The mathematical algorithms for characterizing the white-noise response can be performed by an inexpensive home computer and the same home computer can be used to generate interactive graphics. We, therefore, propose to consider the following questions:

a. Is the white-noise an acceptable workload for a bicycle ergometer, simulating all possible dynamic conditions?

b. Can the white-noise characterization scheme quantify lower limb strength and endurance better than periodic workloads?

c. Can an inexpensive interactive, video game interfaced to the bicycle ergometer significantly improve patient cooperation and performance?

3. Specific Objectives

Quantifying "dynamic strength" is very difficult using periodic variations of resistance and conventional analytical methods. We propose to construct a bicycle ergometer with white-noise modulations of foot pedal resistance in an attempt to characterize the dynamic strength of lower limbs (with and without prostheses). The white-noise (random) modulation will feel like a bumpy road and it will permit a simple analytical method for characterizing the response, i.e., first and second order Wiener Kernels will characterize the torque (response) for any dynamic modulation of resistance (stimulus). The first and second order Wiener Kernels will indicate nonstationarities (e.g., fatigue) and nonlinearities (e.g., muscle imbalances). It will be possible to predict the contractions resulting for a hypothetical impulse of resistance or for any periodic variations of the resistance. Standard measurements of velocity and acceleration are also possible.

In order to encourage the patient to exercise and to facilitate motor control, a video game will be designed to interface with the foot pedals. For example, as the resistance levels are increased, a street scene could be presented on the CRT screen with the street sloping uphill. Conversely, lower resistance levels would occur during downhill scenes. In this manner, the bike could simulate many possible situations represented on the CRT screen, e.g., a bicycle race along a bumpy road -- with many obstacles to avoid. The end result will be a rehabilitation device which is configured like a game.

FINAL REPORT E-23-601

June 15, 1983

1. Backgroud

Strength-training devices are commonly used for the rehabilitation of patients with lower limb injuries or pathologies. In general, exercise equipment can be divided into two categories - static (isometric) and dynamic (isotonic). The latter is much more effective in rebuilding dynamic strengh and cardiovascular endurance; therefore, physical therapy programs typically include many hours of dynamic excercise.

Dynamic exercise can be broken into three possible modes:

1. Constant Resistance
2. Accommodating Resistance, and
3. Variable Resistance

Constant Resistance protocols were first advocated by DeLorne and Watkins. As the name implies, the resistance to motion is held constant during an extended period of motion. Several researchers have attempted Constant Resistance exercise programs with different protocols and claimed advantages.

Accommodating Resistance is consistent with the hypothesis that, by controlling the velocity at which a muscle contracts, the maximum resistance can be imposed upon the contracting muscle. This protocol seems to be especially effective for improving athletic speed and endurance.

The Variable Resistance method for dynamic training is the newest protocol to be used by physical therapists. This protocol entails changing the resistance throughout the period of motion, analogous to real-life situations of walking or running. This methodology is based on the simple hypothesis that the best way to train someone to perform a physical activity is to repeat the activity many times. For example, if you want to train for mountain climbing, the best exercise program will be climbing mountains or to perform analogous movements with comparable (variable) resistances.

2. Significance of Work

The project initiated (see Progress Report date May 15, 1983) during the period of support is the first attempt to apply a white-noise protocol to characterize human strength and endurance, and the proposed interactive graphics will be used for bio-feedback, e.g., plots of EMG versus time. The white-noise calculations and the interactive graphics will be implemented using a relatively low cost home computer. Our intention is to design a computer-controlled ergometer with game graphics which can be marketed (by Nautilus or equivalent manufacturer) for a unit selling price of less than $5.000.00.

3. Relevance of Proposed Work to Patient Care

The veteran population is continuing to age and experience large numbers of lower limb amputations, and the proposed ergometer will be especially useful for rehabilitating amputees. During the last two years, 45 major amputations have

taken place at the VAMC in Atlanta. The number of VA Centers with similar numbers of cases is approximately 80, giving an estimated total of 3,800 cases per year. A special foot pedal linkage will be designed for stumps.

The proposed interactive graphics should motivate patients to work harder and the white-noise protocol will permit quantitative characterizations of dynamic strength. This will hopefully reduce the medical and surgical costs associated with such patient care by requiring less therapy, fewer hospital days, and faster rehabilitation.